IRINA (KALASHNIKOVA) TEZAUR

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EDUCATION

Stanford University, Stanford, California, USA
Ph.D., Computational & Mathematical Engineering (09/2011)
- Thesis Title: "The Discontinuous Enrichment Method for Multi-Scale Fluid Problems"
- Advisor: Professor Charbel Farhat
- Cumulative GPA: 4.08/4.00

University of Pennsylvania, Philadelphia, Pennsylvania, USA
M.A., Mathematics (05/2006)
- Thesis Title: "Local Behavior of Harmonic Functions on the Sierpinski Gasket"
- Advisor: Professor Alexandre A. Kirillov
- Cumulative GPA: 4.00/4.00

B.A., Mathematics, minor in Actuarial Mathematics (05/2006)
- *Summa Cum Laude*, *Phi Beta Kappa*, with Distinction in Mathematics
- Advisor: Professor Herman Gluck
- Cumulative GPA: 3.98/4.00, Major GPA: 4.00/4.00

AWARDS AND FELLOWSHIPS

- Sandia National Laboratories' Public Good Innovator Award for Albany 2.0 (08/2014).
- National Physical Science Consortium (NPSC) Graduate Fellowship (09/2010–09/2011)
- U.S. Department of Defense National Defense Science & Engineering Graduate (NDSEG) Fellowship (09/2007–08/2010)
- 2008 Robert J. Melosh Medal (04/2008)

RESEARCH EXPERIENCE

Sandia National Laboratories, Quantitative Modeling & Analysis Department, Livermore, California, USA
Senior Member of Technical Staff 09/2014–present

Sandia National Laboratories, Computational Mathematics Department, Albuquerque, New Mexico, USA
Senior Member of Technical Staff 10/2011–09/2014
- Lead developer of Albany code.
- Lead developer of Finite Element for Land Ice eXperiments (FELIX) solver to be integrated into the DOE Earth System Model for sea-level rise predictions.
- Reduced order modeling for compressible flow.
- Development of next generation atmospheric modeling code.
- Assisting with the maturation of the templated software stack of Trilinos.

Sandia National Laboratories, Aerosciences Department, Albuquerque, New Mexico, USA
Graduate Technical Research Intern 07/2007–09/2011
- Reduced Order Modeling of Fluid/Structure Interaction: performed a mathematical analysis of the well-posedness, stability and convergence of a Galerkin/POD reduced order model (ROM) for compressible flow; studied boundary condition enforcement in ROMs; studied construction of efficient ROMs for non-linear equations. (Mentor: Matthew F. Barone)
- Modeling of Transitional and Fully Turbulent Pressure Fluctuation Loading (Mentor: Lawrence J. DeChant)

RESEARCH EXPERIENCE (CONTINUED)

Stanford University, Stanford, California, USA

Research Assistant, under supervision of Prof. Charbel Farhat 09/2006–09/2011

- Developed a multi-scale finite element method for advection-dominated fluid problems, in which the standard Galerkin polynomial finite element field is enriched by the free-space solutions of the governing homogeneous PDE, and inter-element continuity is enforced weakly using Lagrange multipliers.

Additional Graduate Research, under supervision of Prof. James V. Lambers 09/2008–06/2009

- In addition to dissertation work, helped advance the Krylov Subspace Spectral (KSS) method of J.V. Lambers, a high order accurate explicit time integration scheme, to time-dependent PDEs discretized in space by the finite element method (FEM).

University of Pennsylvania, Department of Mathematics, Philadelphia, PA, USA

Masters Thesis Work, under supervision of Prof. Alexandre A. Kirillov 09/2005–05/2006

- Studied the local behavior and differentiability of harmonic functions defined on the Sierpinski gasket.

REFEREED JOURNAL ARTICLES

1. **I. Kalashnikova**, M. Perego, A. Salinger, R. Tuminaro, S. Price. "*Albany/FELIX:* A Parallel, Scalable and Robust Finite Element Higher-Order Stokes Ice Sheet Solver Built for Advanced Analysis", *Geosci. Model Develop. Discus.* Geosci.**7** (2014) 8079–8149.

2. **I. Kalashnikova**, M.F. Barone, S. Arunajatesan, B.G. van Bloemen Waanders. "Construction of Energy-Stable Projection-Based Reduced Order Models", *Appl. Math. Computat.* **249** (2014) 569-596.

3. **I. Kalashnikova**, B.G. van Bloemen Waanders, S. Arunajatesan, M.F. Barone. "Stabilization of Projection-Based Reduced Order Models for Linear Time-Invariant Systems via Optimization-Based Eigenvalue Reassignment", *Comput. Meth. Appl. Mech. Engng.* 272 (2014) 251–270.

4. R. Tezaur, **I. Kalashnikova**. "Discontinuous Enrichment Method for Variable Wavenumber Medium-Frequency Helmholtz Problems", *Comput. Meth. in Appl. Mech. & Engng.* 268 (2014) 126–140.

5. **I. Kalashnikova**, M.F. Barone, M.R. Brake. "A Stable Reduced Order Model for Coupled Fluid/Structure Interaction Problems", *Int. J. Numer. Engng.* **95**(2) (2013) 121–144.

6. **I. Kalashnikova**, M.F. Barone. "Efficient Non-Linear Proper Orthogonal Decomposition (POD)/Galerkin Reduced Order Models with Stable Penalty Enforcement of Boundary Conditions". *Int. J. Numer. Meth. Engng.* **90**(11) (2012) 1337–1362.

7. **I. Kalashnikova**, R. Tezaur, C. Farhat. "A Discontinuous Enrichment Method for Variable Coefficient Advection-Diffusion at High Péclet Number". *Int. J. Numer. Meth. Engng.* **87** (2010) 309–335

8. **I. Kalashnikova**, M.F. Barone. "On the Stability and Convergence of a Galerkin Reduced Order Model (ROM) of Compressible Flow with Solid Wall and Far-Field Boundary Treatment". *Int. J. Numer. Meth. Engng* **83** (2010) 1345–1375.

9. C. Farhat, **I. Kalashnikova**, R. Tezaur. "A Higher-Order Discontinuous Enrichment Method for the Solution of High Péclet Advection-Diffusion Problems on Unstructured Meshes". *Int. J. Numer. Meth. Engng* **81** (2010) 604–636.

10. **I. Kalashnikova**, C. Farhat, R. Tezaur. "A Discontinuous Enrichment Method for the Solution of Advection-Diffusion Problems in High Péclet Number Regimes". *Fin. El. Anal. Des.* **45** (2009) 238–250.

11. M.F. Barone, **I. Kalashnikova**, D.J. Segalman, H. Thornquist. "Stable Galerkin Reduced Order Models for Linearized Compressible Flow". *J. Comput. Phys.* **288** (2009) 1932–1946.

MANUSCRIPTS UNDER REVIEW

1. **I. Kalashnikova**, R. Tuminaro, M. Perego, A. Salinger, S. Price. "On the scalability of the Albany/FELIX first-order Stokes approximation ice sheet solver for large-scale simulations of the Greenland and Antarctic ice sheets", submitted to *Numerical and Computational Developments to Advance Multiscale Earth System Models (MSESM)/International Conference on Computational Science (ICCS15)*, Reykjavik, Iceland.

2. **I. Kalashnikova**, M. Perego, A. Salinger, R. Tuminaro, S. Price. "*Albany/FELIX:* A Parallel, Scalable and Robust Finite Element Higher-Order Stokes Ice Sheet Solver Built for Advanced Analysis", submitted to *Geosci. Model Develop.*

MANUSCRIPTS IN PREPARATION

1. A.G. Salinger, E. T. Phipps, R.A. Bartlett, G.A. Hansen, **I. Kalashnikova**, J.T. Ostien, W. Sun, Q. Chen, A. Mota, R.A. Muller, E. Nielsen, X. Gao. "Albany: Using Agile Components to Develop a Flexible, Generic Multiphysics Analysis Code", in preparation for submission *Comput. Sci. Disc.*

2. **I. Kalashnikova**, R. Tezaur, C. Farhat. "Higher-order Extensions of a Discontinuous Galerkin Method for Variable-Coefficient Elliptic Partial Differential Equations", in preparation for submission to *Int. J. Numer. Meth. Engng.*

3. M. Balajewicz, **I. Kalashnikova**, E. Dowell. "Minimal subspace rotation on Stiefel manifold for stabilization and fine-tuning of projection-based reduced order models of the compressible Navier-Stokes equations", in preparation for submission to *Comput. Meth. Appl. Mech. Engng.*

CONFERENCE PAPERS AND TECHNICAL REPORTS

1. **I. Kalashnikova**, S. Arunajatesan, M.F. Barone, B. van Bloemen Waanders, J.A. Fike. "Reduced Order Modeling for Prediction and Control of Large-Scale Systems". *Sandia National Laboratories Report, SAND No. 2013-4693.* Sandia National Laboratories, Albuquerque, NM (2014).

2. E. Nielsen, X. Gao, **I. Kalashnikova**, R.P. Muller, A.G. Salinger, R.W. Young. "QCAD Simulation and Optimization of Semiconductor Double Quantum Dots". *Sandia National Laboratories Report, SAND No. 2013-10575.* Sandia National Laboratories, Albuquerque, NM (2013).

3. **I. Kalashnikova**, M.F. Barone, S. Arunajatesan, B.G. van Bloemen Waanders. "Construction of Energy-Stable Galerkin Reduced Order Models". *Sandia National Laboratories Report, SAND No. 2013-4063.* Sandia National Laboratories, Albuquerque, NM (2013).

4. **I. Kalashnikova**, S. Arunajatesan. "A Stable Galerkin Reduced Order Model (ROM) for Compressible Flow". *WCCM-2012-18407, 10th World Congress on Computational Mechanics (WCCM)*, Sao Paulo, Brazil (07/2012).

5. **I. Kalashnikova**, M.F. Barone. "Stable and Efficient Galerkin Reduced Order Model for Non-Linear Fluid Flow". *AIAA Paper No. 2011–3110, 6th AIAA Theoretical Fluid Mechanics Conference*, Honolulu, HI (06/2011).

6. M.F. Barone, **I. Kalashnikova**, M.R. Brake, D.J. Segalman. "Reduced Order Modeling of Fluid/Structure Interaction". *Sandia National Laboratories Report, SAND No. 2009-7189.* Sandia National Laboratories, Albuquerque, NM (2009).

7. M.F. Barone, D.J. Segalman, H. Thornquist, **I. Kalashnikova**. "Galerkin Reduced Order Models for Compressible Flow with Structural Interaction". *AIAA Paper No. 2008–0612 , 46th AIAA Aerospace Science Meeting and Exhibit*, Reno, NV (01/2008).

PRESENTATIONS

1. **I. Kalashnikova**, M. Perego, A. Salinger, R. Tuminaro, S. Price. "Update on the Albany/FELIX First Order Stokes Solver and the CISM-Albany and MPAS-Albany Dycores", CESM Land Ice Working Group Meeting, National Center for Atmospheric Research (NCAR) - Mesa Lab, Boulder, CO, February 2–3, 2015.

2. **I. Kalashnikova**, J.A. Fike, M.F. Barone, S. Arunajatesan, B. van Bloemen Waanders. "Approaches for building stable projection-based reduced order models", Reduced-Order Modeling Workshop, Sandia National Laboratories, Livermore, CA, 8/7/2014.

3. **I. Kalashnikova**, J.A. Fike, M.F. Barone, S. Arunajatesan, B. van Bloemen Waanders. "Energy-stable Galerkin reduced order models for nonlinear compressible flow", World Congress on Computational Mechanics (WCCM XI), Barcelona, Spain, 7/20/2014–7/25/2014.

4. **I. Kalashnikova**. "Albany/FELIX: A New Parallel, Scalable and Robust First-Order Stokes Ice Sheet Simulation Code", Technical Seminar, Sandia National Laboratories, Livermore, CA, 7/3/2014.

5. **I. Kalashnikova**, A. Salinger, M. Perego, R. Tuminaro, S. Price. "An Update on the Albany/FELIX First Order Stokes Finite Element Solver and Its Coupling to Land Ice Dycores", CESM Annual Workshop, Breckenridge, CO, 6/16/2014–6/19/2014.

6. **I. Kalashnikova**, B.G. van Bloemen Waanders, S. Arunajatesan, M.F. Barone. "Stabilized Projection-Based Reduced Order Models for Uncertainty Quantification". SIAM Conference on Uncertainty Quantification (SIAM UQ14), Savannah, GA, 3/30/2014–4/3/2014.

7. **I. Kalashnikova**, A. Salinger, M. Perego, R. Tuminaro, S. Price. "The Albany/FELIX First-Order Stokes Dycore". *CESM Land Ice Working Group Meeting*, National Center for Atmospheric Research (NCAR) – Mesa Lab, Boulder, CO, 1/30/2014–1/31/2014.

8. **I. Kalashnikova**, A. Salinger, M. Perego, R. Tuminaro, J. Jakeman, M. Eldred. "FELIX: the Albany Ice Sheet Modeling Code". *Albany User Group Meeting*, Sandia National Laboratories, Albuquerque, NM, 1/15/2014.

9. **I. Kalashnikova**, B. van Bloemen Waanders, S. Arunajatesan, M.F. Barone, "Stabilization of Galerkin Reduced Order Models (ROMs) for LTI Systems Using Controllers". *SIAM Conference on Control and Its Applications (CT13)*, San Diego, CA, 7/9/2013.

10. **I. Kalashnikova**, S. Arunajatesan, B. van Bloemen Waanders. "Energy-Stable Galerkin Reduced Order Models for Prediction and Control of Fluid Systems". *SIAM Conference on Computational Science and Engineering (CSE13)* (invited), Boston, MA, 2/26/2013.

11. **I. Kalashnikova**, A. Salinger, R. Tuminaro. "A new unstructured variable-resolution finite element ice sheet stress-velocity solver within the MPAS/Trilinos FELIX dycore of PISCEES". *CESM Land Ice Working Group Meeting*, National Center for Atmospheric Research (NCAR) - Mesa Lab, Boulder, CO, 2/14/2013.

12. **I. Kalashnikova**, S. Arunajatesan. "Towards Feedback Control of Compressible Flows Using Galerkin Reduced Order Models". *Second International Workshop on Model Reduction for Parametrized Systems (MoRePaS II)*, Schloss Reisensburg, Gunzburg, Germany, 10/4/2012.

13. **I. Kalashnikova**, S. Arunajatesan. "A Stable Galerkin Reduced Order Model (ROM) for Compressible Flow". *10th World Congress on Computational Mechanics (WCCM)* (invited), Sao Paulo, Brazil, 07/13/2012.

14. **I. Kalashnikova**, R. Tezaur, C. Farhat. "The Discontinuous Enrichment Method for Multi-Scale Fluid Problems". *7th International Congress on Industrial and Applied Mathematics (ICIAM 2011)*, Vancouver, BC, Canada, 07/22/2011.

15. **I. Kalashnikova**, M.F. Barone. "Stable and Efficient Galerkin Reduced Order Models for Non-Linear Fluid Flow". *6th AIAA Theoretical Fluid Mechanics Conference"*, Honolulu, HI, 06/27/2011.

16. **I. Kalashnikova**, R. Tezaur, C. Farhat. "The Discontinuous Enrichment Method for Advection-Dominated Transport Phenomena in Computational Fluid Dynamics". *10th Bay Area Scientific Computing Day (BASCD 2011)* (invited), Institute for Computational & Mathematical Engineering, Stanford University, Stanford, CA, 05/08/2011.

17. **I. Kalashnikova**, R. Tezaur, C. Farhat. "Recent Extensions of the Discontinuous Enrichment Method to Variable-Coefficient Advection-Diffusion Problems in the High Péclet Regime". *16th International Conference on Finite Elements in Flow Problems (FEF 2011)*, Munich, Germany, 03/23–25/2011.

18. **I. Kalashnikova**. "A Discontinuous Enrichment Method (DEM) for Advection-Dominated Fluid Problems". *Aerosciences Department Seminar* (invited), Sandia National Laboratories, Albuquerque, NM, 08/23/2010.

19. **I. Kalashnikova**, C. Farhat, R. Tezaur. "Recent extensions of the discontinuous enrichment method (DEM) to advection-dominated fluid mechanics problems" (Poster and Presentation). *10th U.S. National Congress on Computational Mechanics (USNCCM-X)*, Ohio State University, Columbus, OH, 07/16/2009.

20. **I. Kalashnikova**. "A Discontinuous Enrichment Method for the Solution of the Advection-Diffusion Equation". *Robert J. Melosh Medal Competition for the Best Student Paper on Finite Element Analysis*, Department of Civil and Environmental Engineering, Duke University, Durham, NC, 04/25/2008.

POSTER PRESENTATIONS

1. **I. Kalashnikova**, D. Martin, S. Price. "Ice sheet dynamical core development for PISCEES". *SciDAC Principal Investigator Meeting*, Hilton Executive Meeting Center, Rockville, MD (July 2013).

2. A.G. Salinger, **I. Kalashnikova**, M. Perego, R.S. Tuminaro, M.S. Eldred, J.D. Jakeman. "Rapid development of an ice sheet climate application using the component-based approach". *CIS External Review*, Sandia National Laboratories, Albuquerque, NM (May 2013).

3. **I. Kalashnikova**, C Farhat, R. Tezaur. "Recent extensions of the discontinuous enrichment method (DEM) to advection-dominated fluid mechanics problems". *10th U.S. National Congress on Computational Mechanics (USACM)*, Ohio State University, Columbus, OH (July 2009).

RESEARCH ADVISING

- **Jeffrey A. Fike**, Component Science and Mechanics Department, Sandia National Laboratories, Albuquerque, NM.

  Graduate Technical Intern (June –August 2014), *Postdoctoral Researcher* (April 2014–present).
  - Project: Proper Orthogonal Decomposition reduced order modeling for the nonlinear compressible Navier-Stokes equations.

ADDITIONAL PROFESSIONAL EXPERIENCE

Watson Wyatt Worldwide, Southfield, Michigan, USA

Actuarial Analyst Intern, Retirement Practice Summers 2005, 2006

- Performed benefit and other actuarial calculations for client plan participants; passed actuarial examinations Course 1 (June 2004) and Course MF (June 2005).

COMPUTER SOFTWARE AND LANGUAGES

- **Programming Languages/Operating Systems:** C++, Fortran, MPI, Trilinos, Python, MATLAB, Maple, LaTeX, Unix, HTML.

- **Open-source software packages** (available on `github`):

  – *Albany 2.0:* an open-source multiphysics analysis package based on the Trilinos multiphysics framework and the SCOREC Parallel Unstructured Mesh Infrastructure (PUMI). [`https://github.com/gahansen/Albany`]

  – *Community Ice Sheet Model (CISM 2.0):* a next-generation ice sheet model that will be used for predicting ice sheet retreat and sea level rise in a warming climate, freely available to the glaciology and climate modeling communities and serves as the ice dynamics component of the Community Earth System Model (CESM). [`https://github.com/cism/cism`]

PROFESSIONAL MEMBERSHIPS

- Society for Industrial & Applied Mathematics (SIAM)
- Sigma Xi Scientific Research Society
- Society of Women Engineers (SWE)
- American Institute of Aeronautics & Astronautics (AIAA)
- Women in Aerospace Engineering (WIA)

REVIEWER

- Journals: *Finite Elements in Analysis and Design*, *International Journal for Numerical Methods in Fluids*, *International Journal for Numerical Methods in Engineering*, *Journal of Computational Physics*, *Numerical Algorithms*, *World Journal of Modeling and Simulation*, *Journal of Computational & Applied Mathematics*, *Computer Methods in Applied Mechanics and Engineering*, *American Mathematical Society*.
- 2014 National Defense Science and Engineering Graduate (NDSEG) Fellowship Review Panelist.
- Program committee member for workshop entitled "Numerical and computational developments to advance multi-scale Earth System Models" at the *International Conference on Computational Science (ICCS 2015)* conference in Reykjavik, Iceland, June 1–3, 2015.

RESEARCH INTERESTS

Numerical solution of PDEs, mixed/hybrid finite element methods, stability and convergence of numerical methods, high performance computing, reduced order modeling, computational fluid dynamics, climate modeling, applied numerical linear algebra.

RELEVANT GRADUATE COURSEWORK

Stanford University, Stanford, California, USA

- Numerical Linear Algebra, Partial Differential Equations of Applied Mathematics, Vector Space Optimization, Wavelets & Signal Processing, Numerical Optimization, Discrete Mathematics & Algorithms, Numerical Solution of Partial Differential Equations, Stochastic Methods in Engineering, Computer Programming in C++ for Earth Scientists & Engineers, Fluid Mechanics, Finite Element Analysis, Compressible Flow, Spectral Methods in Computational Physics, The Finite Element Method for Fluid Mechanics, Advanced Topics in Numerical Linear Algebra, Advanced Topics in Turbulence, Advanced Computational Fluid Mechanics.

University of Pennsylvania, Philadelphia, Pennsylvania,

- Advanced Analysis, Abstract Algebra, Topology, Advanced Linear Algebra, Selections from Modern Mathematics, Ordinary & Partial Differential Equations, Dynamical Systems and Chaos Theory, Probability & Measure Theory, Statistical Inference, Mathematics of Finance, Actuarial Statistics, Applied Statistical Methods for Actuaries.

UNIVERSITY SERVICE AND TEACHING

Stanford University, Stanford, California, USA

Coordinator, Linear Algebra & Optimization Seminar 04–06/2010 (1 quarter)

- Organized weekly seminar featuring guest speakers from different areas of applied mathematics and scientific computing.

Stanford University Chapter of Society for Industrial & Applied Mathematics (SIAM), Webmaster, Board Member & Financial Officer 01/2009–present

- Organized events fostering interest in mathematics and its applications at Stanford, including annual seminar series commemorating Mathematics Awareness Month, seminars highlighting student research, and field trips; represented Stanford chapter of SIAM at annual SIAM summer meeting.

Course Reader & Grader, Mathematics Department 09–12/2007 (1 quarter)

- Served as a course reader and grader for graduate course on partial differential equations of applied mathematics.

University of Pennsylvania, Philadelphia, Pennsylvania, USA

Recitation Instructor, Mathematics Department 09/2005–05/2006 (2 semesters)

- Taught four weekly recitation sections of Calculus II and III, maintained course websites, assigned and graded problem sets.

REFERENCES

1. **Andrew G. Salinger**, Principal Member of Technical Staff, Computational Mathematics Department, Sandia National Laboratories, Albuquerque, NM (agsalin@sandia.gov, 505.845.3523).
2. **Bart G. van Bloemen Waanders**, Principal Member of Technical Staff, Optimization and UQ Department, Sandia National Laboratories, Albuquerque, NM (bartv@sandia.gov, 505.284.6746).
3. **Matthew F. Barone**, Principal Member of Technical Staff, Aerosciences Department, Sandia National Laboratories, Albuquerque, NM (mbarone@sandia.gov, 505.284.8686).
4. **Charbel Farhat**, Vivian Church Hoff Professor of Aircraft Structures, Chairman of Aeronautics and Astronautics Department, Stanford University, Stanford, CA (cfarhat@stanford.edu, 650.723.3840).
5. More references available upon request.